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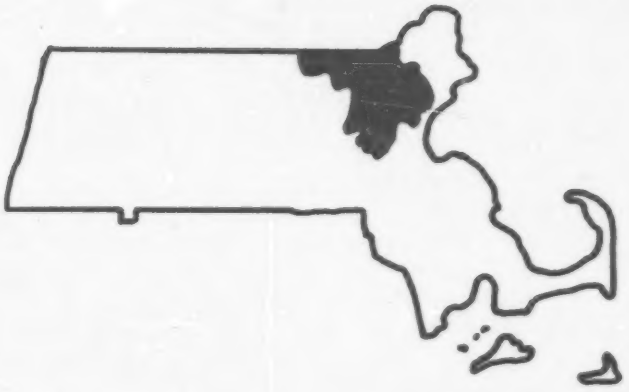
FLOOD INSURANCE STUDY

ORIGINAL

TOWN OF WAYLAND, MASSACHUSETTS
MIDDLESEX COUNTY



FEBRUARY 19, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 250224

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TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgements	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	4
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	5
3.0	ENGINEERING METHODS	5
	3.1 Hydrologic Analyses	6
	3.2 Hydraulic Analyses	8
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	9
	4.1 Flood Boundaries	9
	4.2 Floodways	9
5.0	INSURANCE APPLICATION	15
	5.1 Reach Determinations	15
	5.2 Flood Hazard Factors	17
	5.3 Flood Insurance Zones	17
	5.4 Flood Insurance Rate Map Description	18

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TABLE OF CONTENTS - continued

	Page
6.0 OTHER STUDIES	18
7.0 LOCATION OF DATA	18
8.0 BIBLIOGRAPHY AND REFERENCES	18

FIGURES

Figure 1 - Vicinity Map	3
Figure 2 - Floodway Schematic	14

TABLES

Table 1 - Summary of Discharges	7
Table 2 - Floodway Data	11 - 13
Table 3 - Flood Insurance Zone Data	16

EXHIBITS

Exhibit 1 - Flood Profiles	
Sudbury River	Panels 01P - 05P
Pine Brook	Panel 06P
Mill Brook	Panels 07P - 09P
Hayward Brook	Panels 10P - 11P
Snake Brook	Panels 12P - 13P
Exhibit 2 - Flood Boundary and Floodway Map Index	
Flood Boundary and Floodway Map	

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

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FLOOD INSURANCE STUDY
TOWN OF WAYLAND, MASSACHUSETTS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Wayland, Middlesex County, Massachusetts, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Howard, Needles, Tammen and Bergendoff, for the Federal Emergency Management Agency (FEMA), under Contract No. H-4004. This work was completed in November 1979. The revised hydrologic and hydraulic analyses for Hayward Brook were performed by Dewberry & Davis, under agreement with FEMA. The revised work was completed in April 1985.

1.3 Coordination

An initial Consultation and Coordination Officer's (CCO) meeting was held on April 14, 1976 and was attended by representatives of FEMA, the Town of Wayland, and Howard, Needles, Tammen and Bergendoff (the study contractor). The purpose of the meeting was to identify the streams to be studied by detailed methods.

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Upon initiation of the study, a legal notice was placed in the Wayland-Weston Town Crier one day a week for three consecutive weeks, beginning August 5, 1976, to notify all interested persons so that they could submit any relevent facts and technical data concerning local flood hazards.

During the course of the study, a search for basic data was made at all levels of government, including the Conservation Commission, the Planning Board, the Town Surveyor, the Town Assessor, the Historical Society and the public library. Contact was made with the U. S. Army Corps of Engineers (COE); the U. S. Geological Survey (USGS); U. S. Department of Agriculture, Soil Conservation Service (SCS); and the Metropolitan District Commission (MDC).

On January 26, 1981, the results of the study were reviewed at a final CCO meeting, attended by representatives of FEMA, the Town of Wayland, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Wayland, Middlesex County, Massachusetts. The area of study is shown on the Vicinity Map (Figure 1).

The Sudbury River and portions of Pine Brook, Mill Brook, Hayward Brook and Snake Brook were studied by detailed methods. Pine Brook was studied by detailed methods from its confluence with the Sudbury River to the confluence of Hayward Brook. Mill Brook from its confluence with Pine Brook to Claypit Hill Road was studied by detailed methods. Hayward Brook was studied by detailed methods from its confluence with Pine Brook to a point approximately 250 feet upstream of Boston and Maine Railroad. Snake Brook, including backwater elevations from Lake Cochituate, was studied by detailed methods from Commonwealth Avenue to Thompson Street. The detailed study for Hayward Brook was revised using data provided by the USGS. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

Portions of Pine Brook, Mill Brook, Hazal Brook, Hayward Brook, Snake Brook, and several unnamed tributaries were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Town of Wayland.

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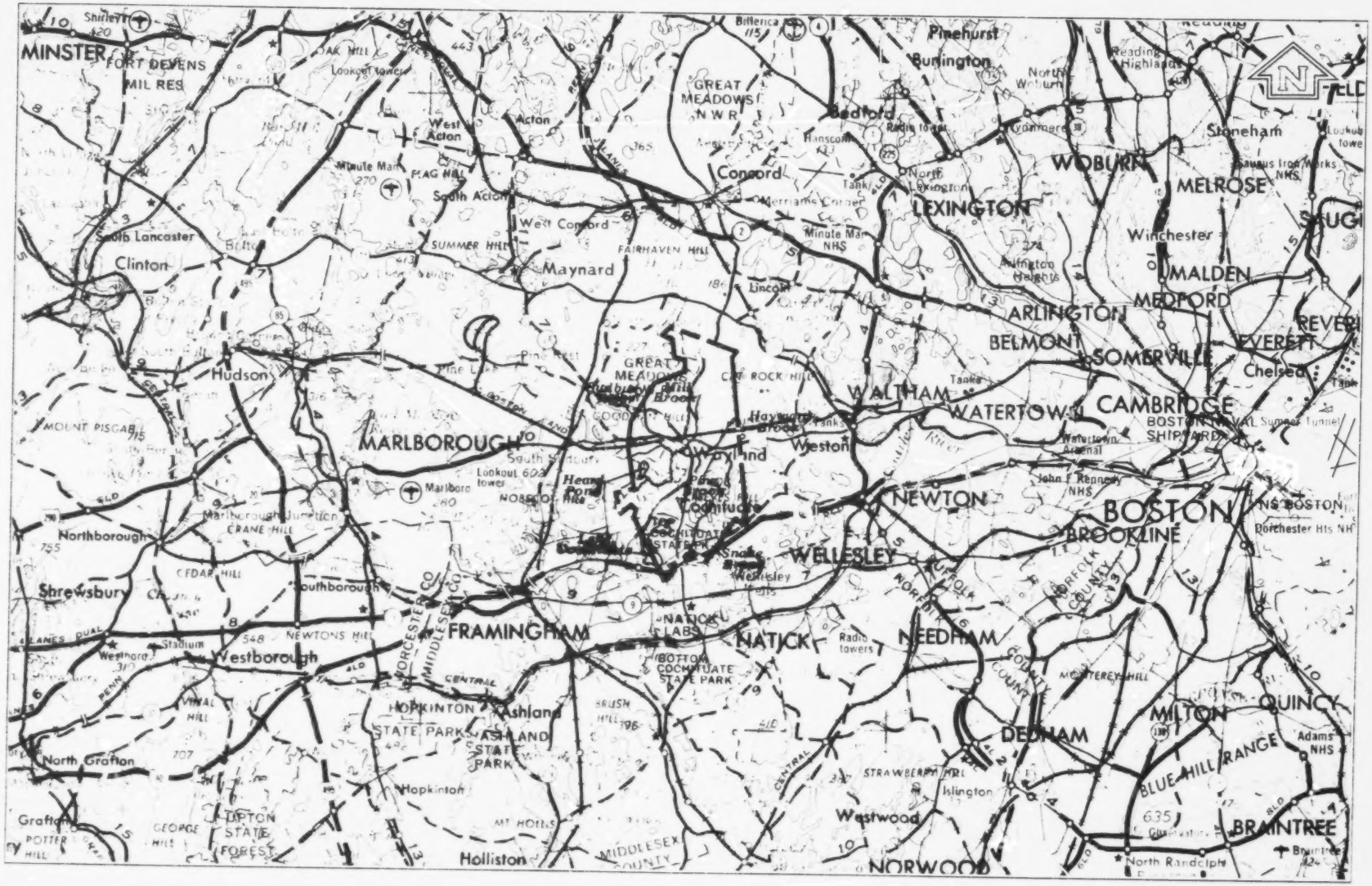
MINSTER
FORT DEVENS MIL RES
Shirley
Billerica
Pinehurst
Burlington
GREAT MEADOWS N.W.R.
Bedford
Concord
West Acton
Acton
South Acton
Minute Man
FLAG HILL
West Concord
SUMMER HILL
Maynard
FAIRHAVEN HILL
South Lancaster
Clinton
Hudson
MOUNT PISGAH
MARLBOROUGH
Marlboro
Lookout 602
Northborough
CRANE HILL
CEDAR HILL
Shrewsbury
Southborough
NEWTONS HILL
Westborough
Stadium
FRAMINGHAM
HOPKINTON STATE PARK
Hopkinton
Ashland
ASHLAND STATE PARK
North Grafton
Grafton
POTTER HILL
GEORGE HILL
UPTON STATE FOREST
Holliston
MT. HOPE
MIDDLESEX COUNTY
NATICK LABS
NATICK
BOSTON COCHITUATE STATE PARK
Radio towers
Lookout tower
Cochituate
Snake Hill
Wellesley
Wellesley Hills
NEEDHAM
NORFOLK COUNTY
MONTEREY HILL
DEDHAM
Islington
STRAWBERRY HILL
Westwood
NORWOOD
North Randolph
BRAINTREE
Braintree
BLUE HILL RANGE
MILTON
QUINCY
Adams NHS
Wayland
Weston
Heard Pond
Hayward Brook
Tanks
GREAT MEADOWS
Old Rock Hill
Lincoln
Arlington Heights
North Lexington
Merriams Corner
Minute Man NHS
WALTHAM
WATERTOWN
Watertown Arsenal
CAMBRIDGE
BOSTON NAVAL SHIPYARD
Boston Naval Support Annex
John F. Kennedy NHS
NEWTON
BOSTON
BROOKLINE
Dorchester Hts NHS
Dorchester Hts NH
Chelsea
EVERETT
SOMERVILLE
BELMONT
ARLINGTON
MEDFORD
MALDEN
Winchester
MELROSE
WOBURN
Stoneham
Lookout tower
Saugus Iron Works NHS
Reading Highlands
North Woburn
Wyoming
Tanks
Radio tower
Hanscom
Lookout tower
Beaver Brook
Good Hill
Pine Hill
Boston Line
Fitchburg Line
Worcester Line
Penn Central
Old Colony
Boston and Maine
Framingham Secondary
Norfolk County
Middlesex County
Suffolk County
Dedham County
Mt. Auburn
Brush Hill
Vinal Hill
Penn

2.2 Community Description

The Town of Wayland, located in eastern Massachusetts, 18 miles from Boston, has a population of 13,461 (Reference 1). Wayland is bordered by the Towns of Sudbury and Framingham to the west, Natick to the south, Weston to the east, and Concord and Lincoln to the north.

Wayland was originally settled in 1639 as a part of Sudbury, and was separated into "East Sudbury" in 1780. The town acquired the name of Wayland in 1835. Throughout its history, agriculture has played an important part in the economy of Wayland. In the nineteenth century the shoe industry was introduced to the Cochituate area of Wayland. Primarily a residential suburb of Boston, the economy of Wayland is based on manufacturing with wholesale and retail trade as secondary sources of income.

The residential development in Wayland is widespread with low density single family homes. Higher density residential and commercial development has occured in the Cochituate section of Wayland. Portions of the floodway for the Sudbury River have experienced residential development for a long period of time.

The Sudbury River, the principle waterway in Wayland, has its headwaters in Cedar Swamp, in the Towns of Westborough and Hopkinton. The river flows to the east, through the Towns of Southborough and Ashland, and then north through the MDC Framingham Reservoirs Nos. 1 and 2. The river flows north to form a major portion of the corporate limits between the Towns of Sudbury and Wayland. In this area, the Sudbury River channel is surrounded by extensive wetlands that make up a major portion of the Sudbury River flood plain. Five and a quarter miles north of the Wayland-Sudbury-Lincoln-Concord corporate limits the Sudbury River joins the Assabet River in Concord, Massachusetts, to form the Concord River.

The Town of Wayland has generally rolling topography with some level areas in the western portion, along the Sudbury River. The climate of the town is moderate with a normal January temperature of 28 degrees Fahrenheit (°F) and a normal July temperature of 73°F. The average annual precipitation in the Town of Wayland is 43.0 inches.

2.3 Principal Flood Problems

Low-lying areas of Wayland are subject to periodic flooding caused by the overflow of the Sudbury River, Pine Brook, Hayward Brook, Snake Brook and Mill Brook. The most severe flooding along the Sudbury River in recent years occurred during August 1955. The flood of August 1955 resulted from two tropical storms that arrived almost concurrently. Tropical Storm Connie, occuring between August 11th and 15th, created saturated

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ground conditions. Tropical Storm Diane deposited from 7 to 13 inches of rain onto the Town of Wayland between August 17th and 20th. As a result of these two storms, roads and bridges were overtopped, and residences and businesses were flooded. Commonwealth Road (State Route 30), Boston Post Road (U. S. Route 20) and Pelham Island Road were flooded while Sherman Bridge Road and Stone Bridge Road were closed and impassible.

Flooding has occured within the Sudbury River flood plain as a result of the floods of November 1927, March 1936, July and September 1938, August 1955, March 1968 and January 1979 (References 2, 3, 4, 5 and 6).

The flood of 1968 was caused by spring runoff from melting snow as a result of warm weather and precipitation. The runoff from the melting snow saturated the swamps and wetlands and caused above normal stream flow. From 5 to 7 inches of rain fell between March 17th and 18th. Runoff from precipitation, combined with higher than normal spring runoff, created flood conditions for many parts of the town.

The flood of January 1979 was caused by heavy rainfall in combination with frozen ground conditions. These conditions caused flooding in many areas, particularly along the Sudbury River and tributaries controlled by backwater effects from the Sudbury River.

2.4 Flood Protection Measures

Cedar Swamp, in the Towns of Westborough and Hopkinton, provides a natural upstream storage area for the Sudbury River which substantially decreases peak flows and thus the severity of flooding along the Sudbury River, as it passes through the Town of Wayland. The Sudbury Reservoir and the Framingham Reservoir systems provide significant storage volume which reduces peak flows on the Sudbury River.

A large natural storage area is also present in the drainage basin of Hayward Brook. It substantially reduces the peak flows and severity of flooding along Hayward Brook.

The Town of Wayland, through amendment to its zoning by-laws, has adopted measures to protect its flood plain and wetland areas. An extensive portion of the Sudbury River flood plain in Wayland is further protected from development by being designated as the Great Meadow Wildlife Refuge.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or

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500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

For the Sudbury River, the discharge-frequency data was obtained using computer modeling techniques developed by the SCS (Reference 7). In this method, a precipitation event is simulated over a basin, the runoff is calculated and the resulting quantity of flow routed through portions of streams and control structures. The 10-, 50-, 100- and 500-year peak discharges were determined by applying the appropriate total rainfall depth associated with a particular frequency.

To define data for Snake Brook, Pine Brook, Mill Brook and Hayward Brook, regional discharge-frequency equations were utilized (Reference 8). These equations, which related basin characteristics to stream flow, provided the method for determining the 10-, 50-, 100- and 500-year peak discharges. The 500-year peak discharges were obtained graphically using the data obtained from the discharge-frequency equations. Discharge-frequency data obtained as described above were compared with previously published data, where such data were available and applicable. The 100-year discharges for the streams studied by approximate methods were calculated using regional discharge-frequency equations (Reference 8).

The revised hydrologic analysis for Hayward Brook was performed using USGS regional equations for small rural streams in Massachusetts (Reference 9). Gage data taken at the U. S. Route 20 culvert at Hayward Brook was used in the regression analysis to develop the regional equations for the 10-, 50- and 100-year discharges. The 500-year discharges were derived graphically.

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A summary of drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
SUDBURY RIVER					
At the downstream corporate limits	153.78	2,500	3,860	4,490	5,950
Downstream of Sherman Bridge Road	146.21	2,570	3,970	4,610	6,090
Downstream of Old Sudbury Road	140.95	2,810	4,330	5,080	6,800
Downstream of Boston Post Road	140.07	2,830	4,440	5,235	7,030
Downstream of Pelham Island Bridge	116.89	2,850	4,500	5,310	7,130
Downstream of Potter Road	107.60	2,990	4,740	5,590	7,500
PINE BROOK					
At confluence with Mill Brook	5.84	220	340	440	540
At confluence of Hayward Brook	3.97	160	251	294	400
MILL BROOK					
At confluence with Pine Brook	5.00	70	90	100	130
HAYWARD BROOK					
At its confluence with Pine Brook	3.39	161	260	312	442
At Boston Post Road	2.32	83	140	175	272
At private drive bridge	1.48	62	104	130	202
SNAKE BROOK					
At confluence with Lake Cochituate	2.52	120	180	210	280

For the Sudbury River, discharges increase in the upstream direction of flow due to storage effects in the overbank areas along the streams.

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3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (References 10 and 11). The HEC-2 model uses the revised discharges for Hayward Brook. The floodway run for Hayward Brook is different from the original floodway run due to the upstream variance of the discharges. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Starting water-surface elevations for the Sudbury River were determined by backwater computations done for the Flood Insurance Studies for the Towns of Concord and Lincoln (References 12 and 13). Starting water-surface elevations for Pine Brook, Mill Brook, Hayward Brook, and Snake Brook were determined by the slope/area method. The backwater reach on Snake Brook from Lake Cochituate was determined from a rating curve developed for the culvert at Commonwealth Avenue.

Cross sections for the backwater analyses for the Sudbury River, Pine Brook, Mill Brook, Hayward Brook and Snake Brook were obtained from photogrammetric mapping (Reference 14). The below-water portions of the cross sections were obtained by field measurements. All bridges and culverts were surveyed to obtain elevation data and structural geometry in order to compute the significant backwater effects of these structures.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness factors (Manning's "n") for the streams studied by detailed methods were estimated on the basis of field inspection and through the analysis of aerial photography (Reference 14). For the Sudbury River, the channel "n" value ranged from 0.025 to 0.040 and the overbank "n" value ranged from 0.070 to 0.120. For Pine Brook, Mill Brook, Hayward Brook and Snake Brook the channel "n" value was 0.035 and the overbank "n" value ranged from 0.050 to 0.075.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

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The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (References 15, 16, and 17).

For the areas studied by approximate methods, the boundary of the 100-year flood was delineated using the Flood Hazard Boundary Map for the Town of Wayland (Reference 18). Flooding on and around Lake Cochituate was determined to be minimal, although it causes backwater flooding on Snake Brook.

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a

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tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway widths for the Sudbury River and Snake Brook extend beyond the corporate limits.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain developments are shown in Figure 2.

Near the mouths of streams studied in detail, flooding computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 2 for certain downstream cross sections of Pine Brook, Mill Brook, Hayward Brook, and Snake Brook are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

One aspect of floodway and flood plain encroachment is sometimes overlooked and more often neglected: the cumulative effects of encroachment on flood discharge magnitude. Generally, as encroachment occurs, temporary storage areas are lost, velocities are increased, and the magnitude of discharge increases. As flood waters move downstream, the increase can become significant. The combined effect of a narrower flood plain and greater discharge can, due to hydraulic effects alone, produce a flood stage that exceeds the anticipated 100-year flood.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Sudbury River								
A	5.21	500[2]	6,976	0.6	122.0	122.0	123.0	1.0
B	5.69	1,300[2]	15,403	0.3	122.0	122.0	123.0	1.0
C	6.15	350[2]	4,783	0.9	122.1	122.1	123.1	1.0
D	6.33	830[2]	9,250	0.5	122.1	122.1	123.1	1.0
E	6.91	1,550[2]	16,171	0.3	122.1	122.1	123.1	1.0
F	7.41	885[2]	9,464	0.5	122.3	122.3	123.2	0.9
G	7.57	930[2]	10,477	0.4	122.4	122.4	123.3	0.9
H	8.16	1,900[2]	20,935	0.2	122.4	122.4	123.3	0.9
I	8.95	2,950[2]	29,427	0.2	122.4	122.4	123.3	0.9
J	9.68	1,900[2]	19,590	0.2	122.4	122.4	123.3	0.9
K	10.21	2,000	18,696	0.3	122.5	122.5	123.4	0.9
L	10.66	1,450	11,481	0.4	122.6	122.6	123.5	0.9
M	11.38	650	8,393	0.6	122.8	122.8	123.6	0.8
N	11.72	680	8,803	0.6	122.9	122.9	123.7	0.8
O	12.27	315	3,972	1.3	123.0	123.0	123.8	0.8
P	12.43	465	6,256	0.8	123.1	123.1	123.9	0.8
Q	12.77	940	11,502	0.5	123.1	123.1	123.9	0.8
R	13.53	2,070	20,901	0.3	123.2	123.2	124.0	0.8
S	14.42	490[2]	4,655	1.1	123.4	123.4	124.2	0.8
T	14.88	200[2]	2,454	2.2	123.7	123.7	124.5	0.8

[1]Miles above confluence with Concord River

[2]This width extends beyond corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF WAYLAND, MA

(MIDDLESEX CO.)

FLOODWAY DATA

SUDBURY RIVER

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Snake Brook								
A	650	24	50	4.2	138.9	134.3[3]	134.3	0.0
B	4,250	100[2]	537	0.4	147.7	147.7	147.7	0.0
C	5,837	125	529	0.4	147.8	147.8	147.9	0.1
D	7,272	10	34	6.1	153.3	153.3	154.3	1.0
E	9,578	65	222	0.9	166.4	166.4	166.4	0.0

[1]Feet above Commonwealth Avenue

[2]This width extends beyond corporate limits

[3]Elevation computed without consideration of backwater effects from Lake Cochituate

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF WAYLAND, MA

(MIDDLESEX CO.)

FLOODWAY DATA

SNAKE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Pine Brook								
A	920[1]	20	61	6.5	122.8	112.2[3]	113.1	0.9
B	1,930[1]	120	436	0.9	122.8	114.4[3]	114.9	0.5
C	3,790[1]	77	168	1.7	122.8	115.9[3]	116.8	0.9
D	4,380[1]	17	59	5.0	122.8	118.8[3]	118.9	0.1
E	5,270[1]	115	300	1.0	122.8	119.2[3]	119.7	0.5
F	6,660[1]	75	192	1.5	122.8	120.7[3]	121.6	0.9
Mill Brook								
A	1,880[2]	87	418	0.2	122.8	121.7[3]	121.7	0.0
B	4,175[2]	98	482	0.2	125.8	125.8	125.8	0.0
C	7,330[2]	145	349	0.3	128.6	128.6	128.7	0.1
Hayward Brook								
A	660[2]	80	166	1.9	122.8	121.1[3]	122.0	0.9
B	1,250[2]	17	28	6.3	123.7	123.7	123.7	0.0
C	1,605[2]	87	469	0.4	130.1	130.1	130.1	0.0
D	2,745[2]	31	143	1.2	130.1	130.1	130.1	0.0
E	3,135[2]	10	17	7.5	136.0	136.0	136.0	0.0
F	3,869[2]	104	255	0.5	146.0	146.0	146.5	0.5
G	4,359[2]	84	137	1.0	146.3	146.3	146.7	0.4
H	4,999[2]	242	1,810	0.1	156.9	156.9	156.9	0.0

[1]Feet above confluence with the Sudbury River

[2]Feet above confluence with Pine Brook

[3]Elevation computed without consideration of backwater from Sudbury River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF WAYLAND, MA

(MIDDLESEX CO.)

FLOODWAY DATA

PINE BROOK · MILL BROOK · HAYWARD BROOK

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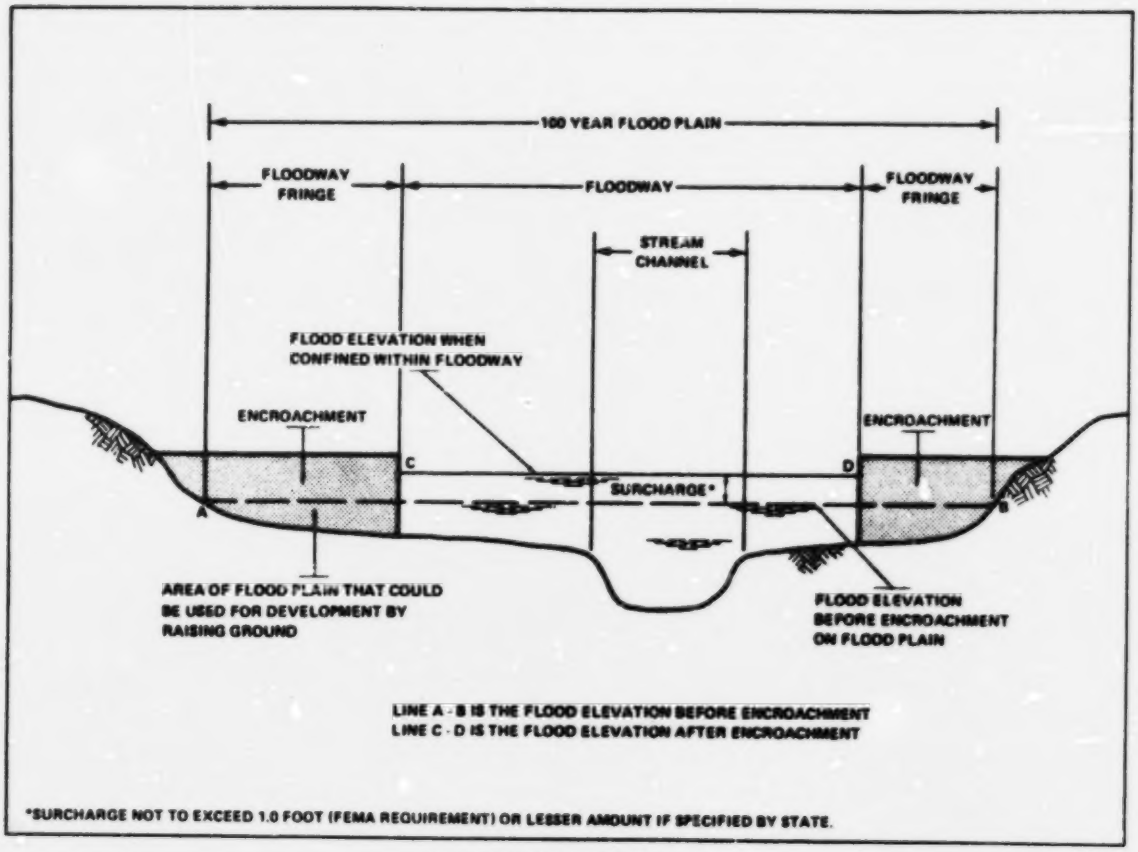
100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC

Figure 2

FEMA does not encourage filling in the floodway fringe area. Local officials should be aware that even a 1-foot rise in the water- surface elevation can cause flooding in areas which would have received little or no flooding if such filling had not taken place. Careful consideration of the economic and human dislocation which will be caused by a rise in flood heights should be made before filling is allowed. Large quantities of fill in the fringe area could also disrupt the flood plain ecosystem, causing a major impact on local environmental resources.

Communities are encouraged by FEMA to adopt wider, more restrictive floodways to minimize the amount of fill allowed in the fringe areas. Such actions also meet the intent of the Massachusetts Wetland Protection Act (Massachusetts General Law, Chapter 131, Section 40). Under the provisions of the act, the local conservation commission and Massa-

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chusetts Department of Environmental Quality Engineering have the authority to impose "orders of condition" regulating flood plain areas subject to flooding and wetlands alterations. The orders normally require compensatory storage to replace any loss resulting from proposed flood plain alterations. "Compensatory storage" is the volume of flood plain storage which must be created for flood water retention equaling the storage removed by alteration. Such requirements in flood plain areas are designed to minimize adverse effects on flood plain hydrology.

In order to achieve a unified flood plain and wetlands management program, numerous Massachusetts communities have adopted local zoning by-laws, ordinances, subdivision regulations and local Board of Health regulations augmenting the minimum requirements of the Flood Insurance Program and the Wetlands Protection Act. FEMA encourages the use of this Flood Insurance Study as a technical basis for adoption of a broader, more encompassing flood plain management program than is required to meet the Flood Insurance Program.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the Town of Wayland.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the Town of Wayland are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Sudbury River							
Reach 1	01,02, 04	-3.8	-1.2	+3.1	040	A8	Varies
Mill Brook							
Reach 1	02	-2.0	-0.0	+1.2	020	A4	Varies
Reach 2	02	-0.9	-0.1	+0.7	010	A2	Varies
Hayward Brook							
Reach 1	02	-1.4	-1.3	+4.7	015	A3	Varies
Reach 2	02	-0.8	-0.2	+0.2	010	A2	Varies
Reach 3	02	-6.8	-2.7	+0.3	070	A14	Varies
Snake Brook							
Reach 1	04	-0.8	-0.2	+0.3	010	A2	Varies
Reach 2	04	-2.3	-0.2	+0.2	025	A2	Varies
Reach 3	04	-0.9	-0.2	+0.3	010	A5	Varies
Reach 4	04	-4.3	-1.4	+0.5	045	A9	Varies
Reach 5	04	-2.6	-0.7	+0.3	025	A5	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF WAYLAND, MA
(MIDDLESEX CO.)

FLOOD INSURANCE ZONE DATA

SUDBURY RIVER - MILL BROOK - HAYWARD BROOK - SNAKE BROOK

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A2, A3, A4, A5, A8, A9, and A14:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 3.

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5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of Wayland is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Flood Insurance Studies for the Towns of Sudbury and Framingham have been completed (References 19 and 20). The results of this study are in exact agreement with the results of those studies.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

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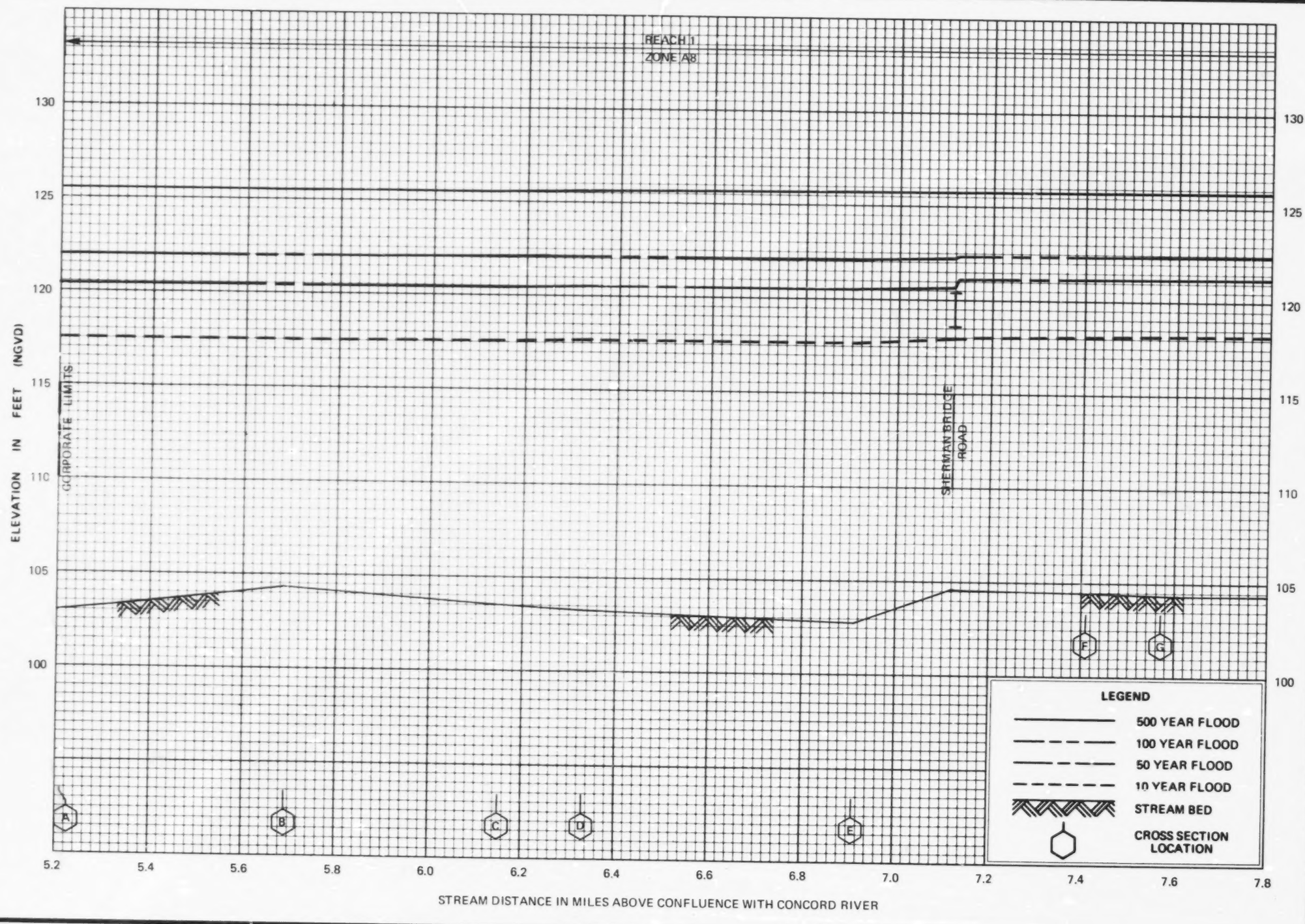

FLOOD PROFILES

SUDBURY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF WAYLAND, MA
(MIDDLESEX CO.)

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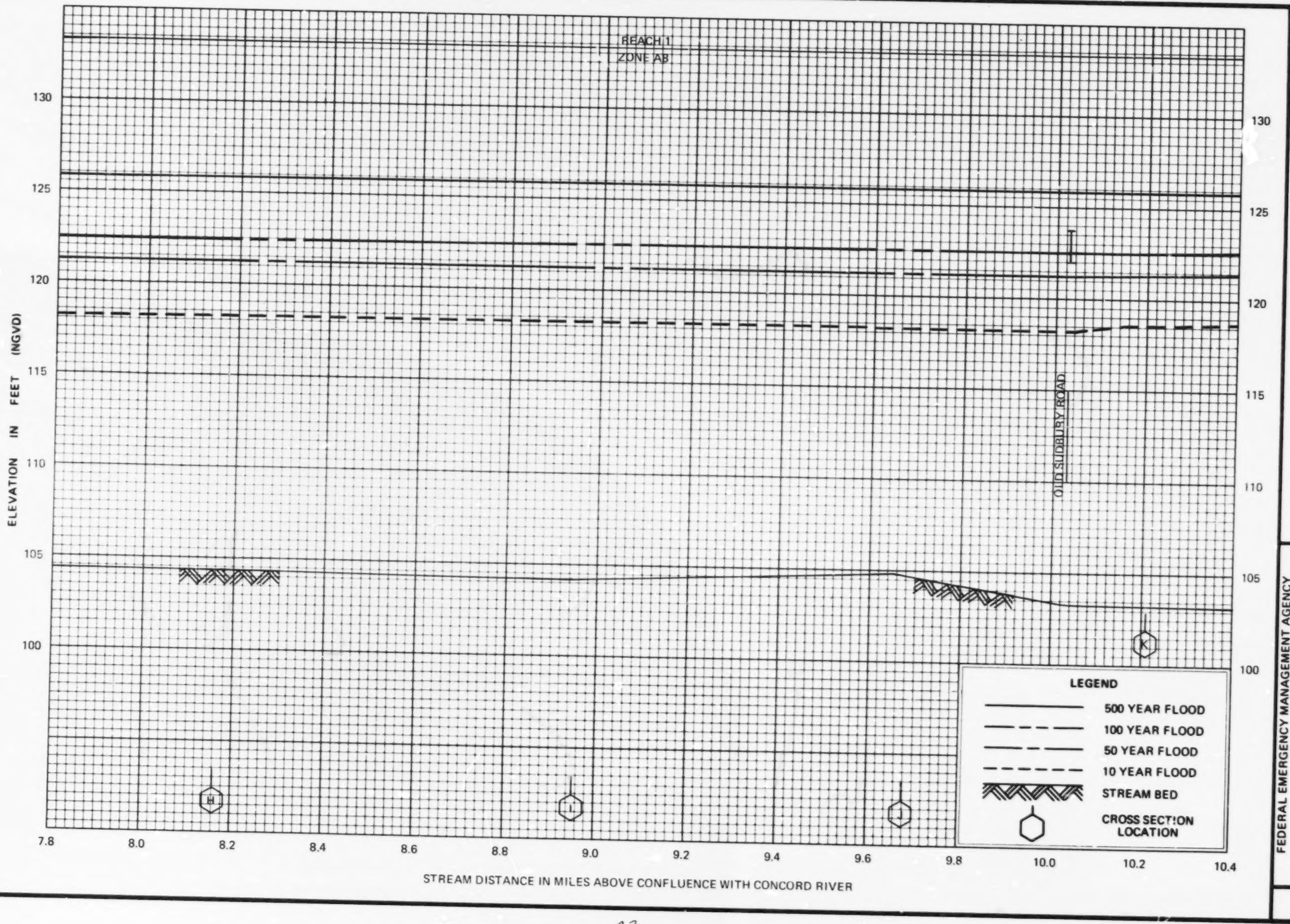

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TOWN OF WAYLAND,MA
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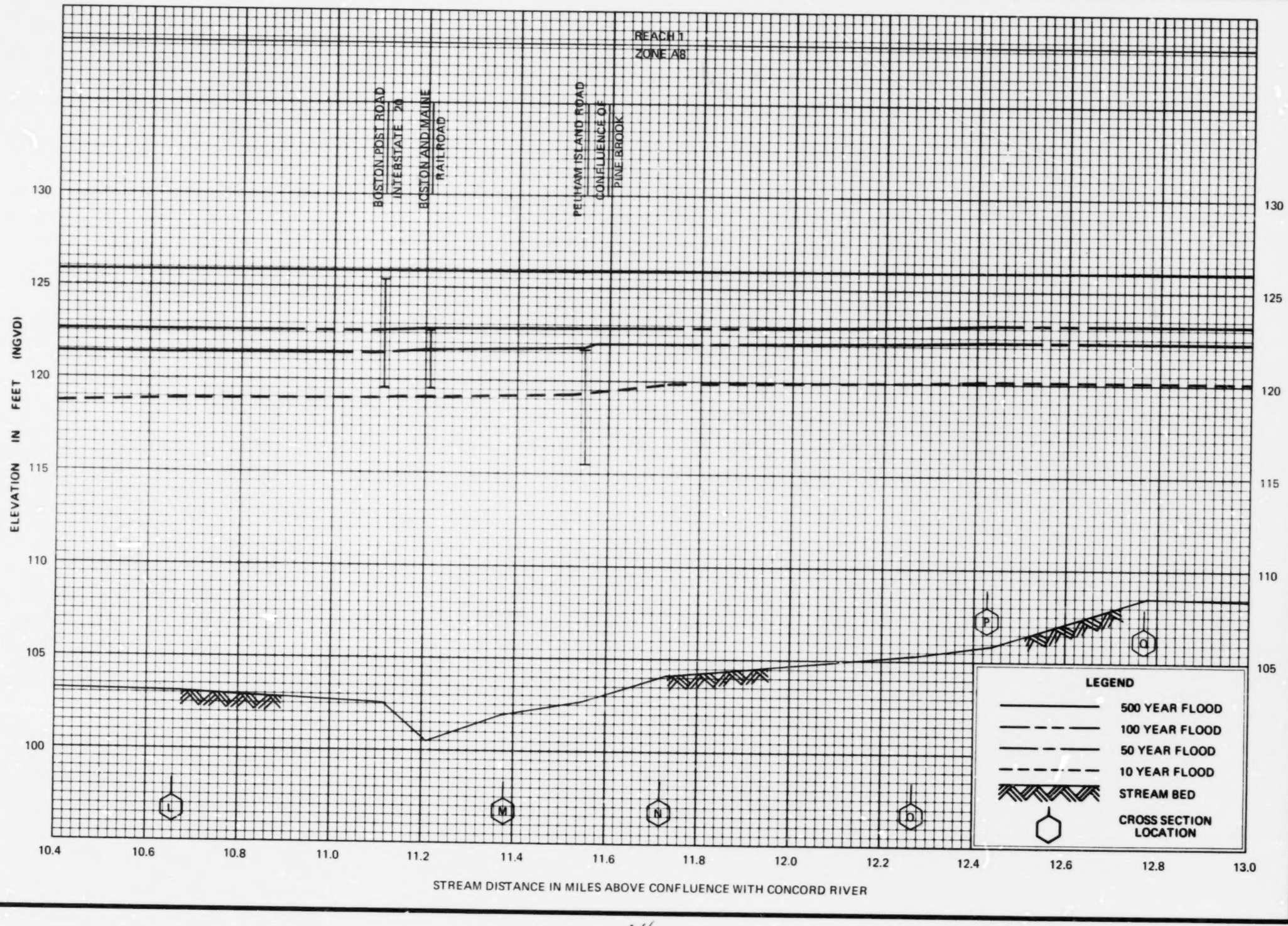

FLOOD PROFILES

SUDBURY RIVER

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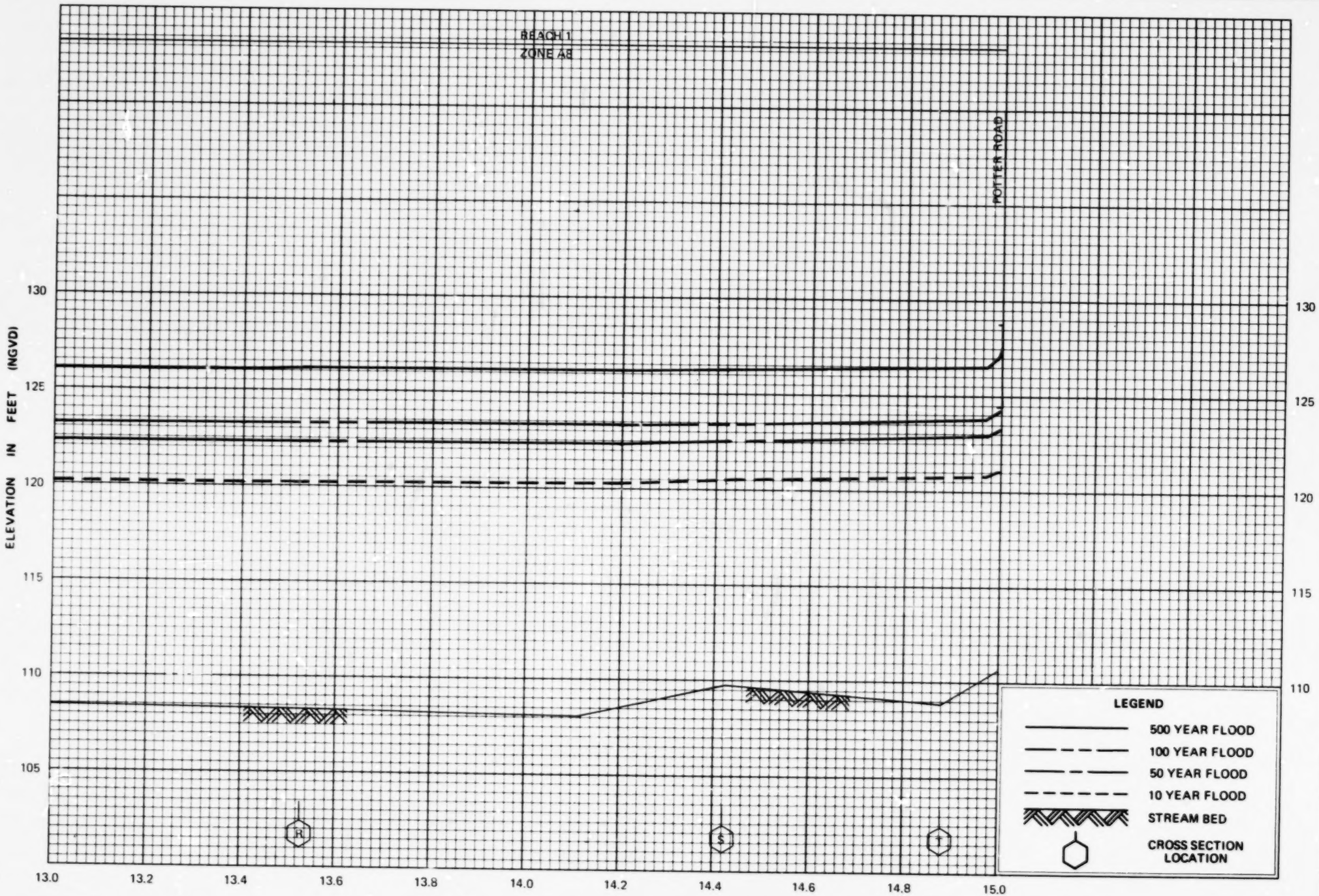

FLOOD PROFILES

SUDBURY RIVER

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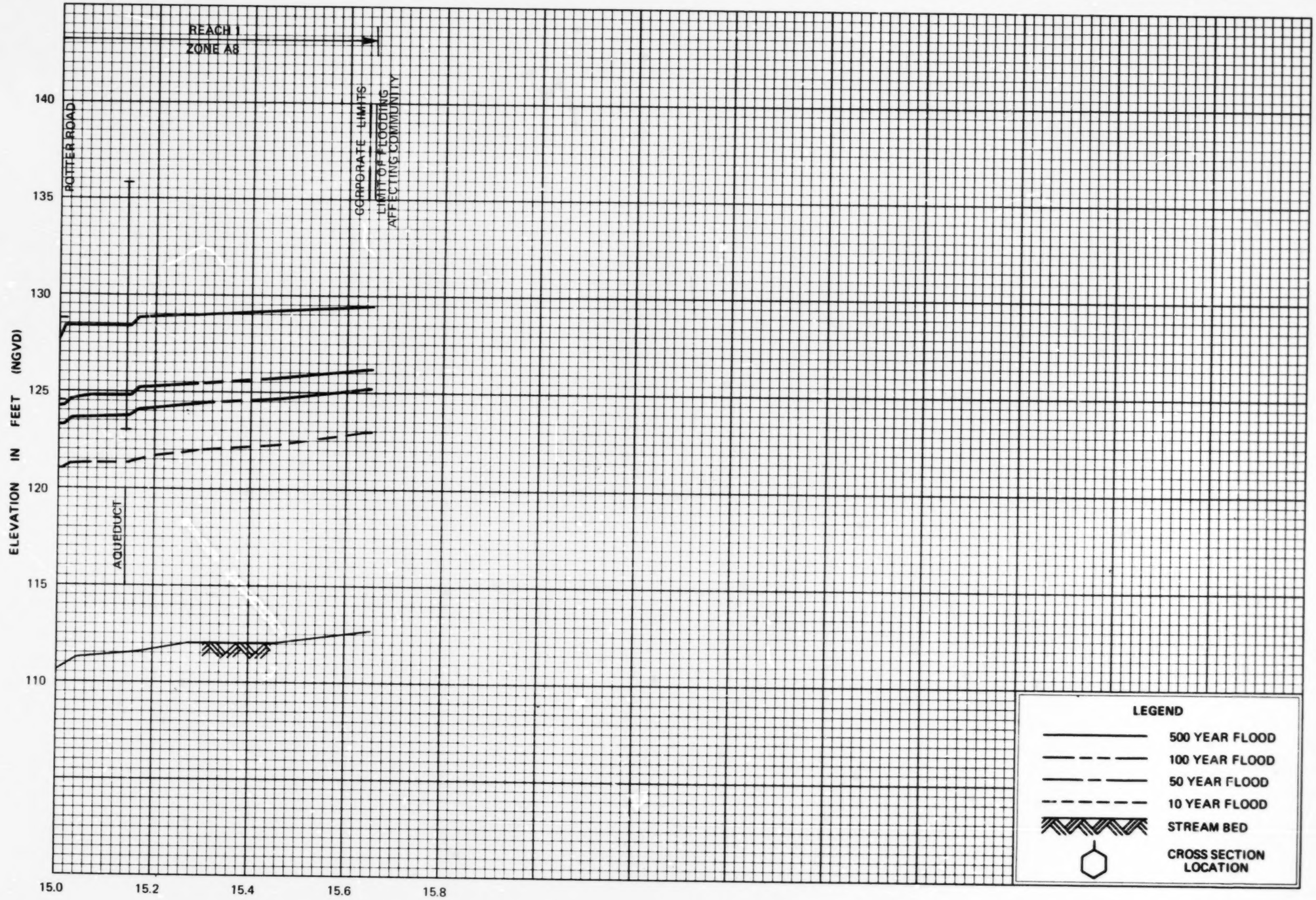

FLOOD PROFILES

SUDBURY RIVER

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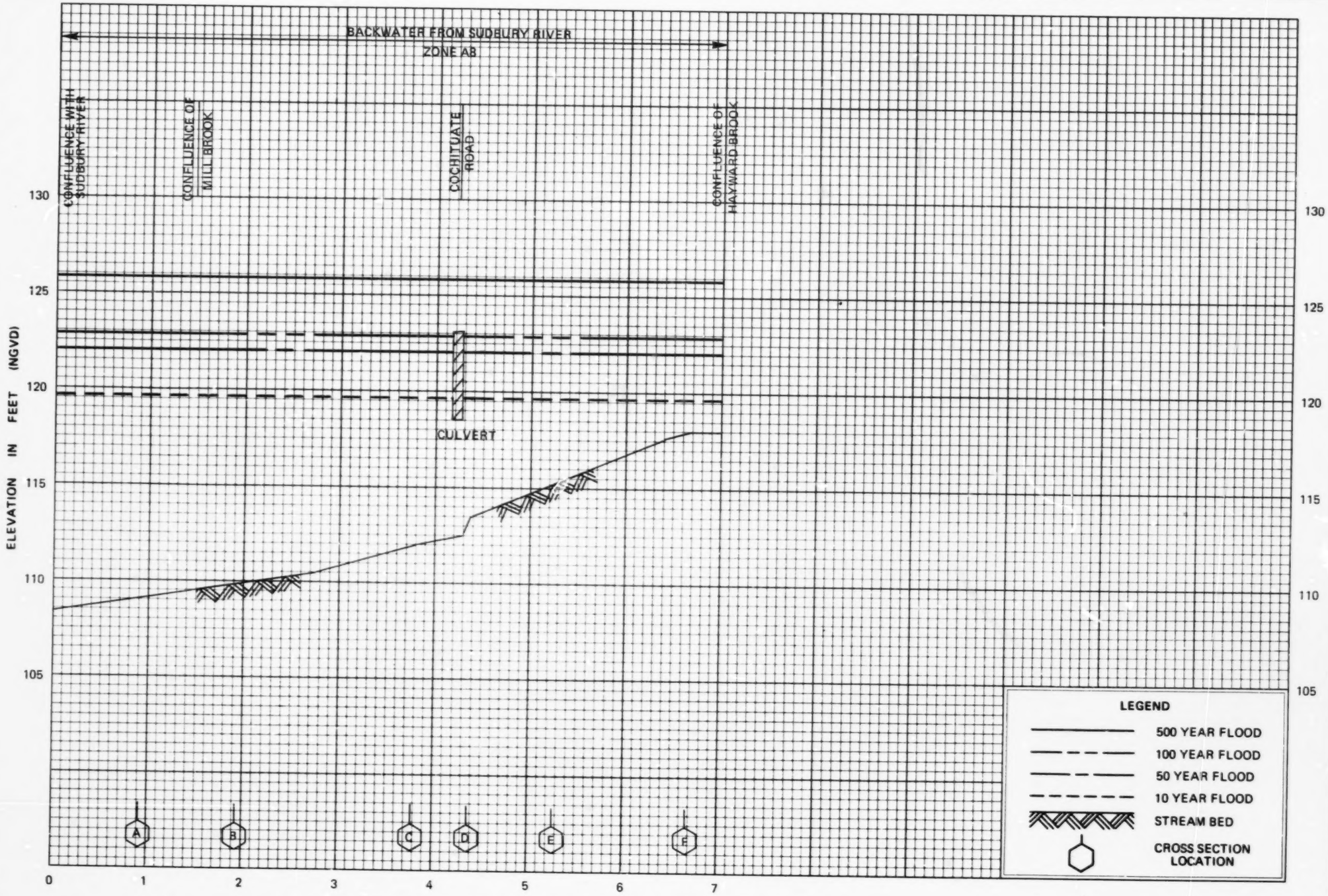

FLOOD PROFILES

PINE BROOK

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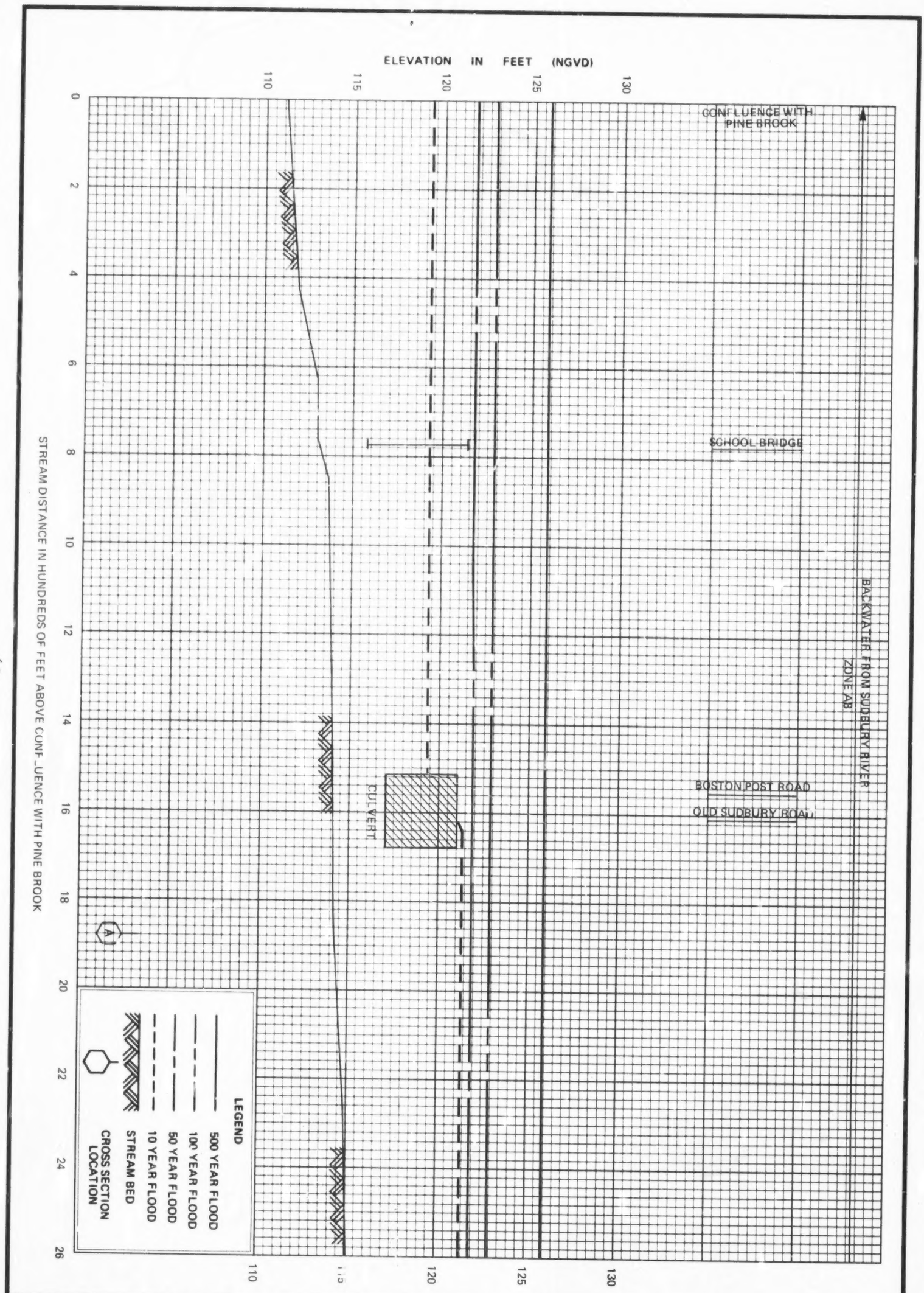

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FLOOD PROFILES

MILL BROOK

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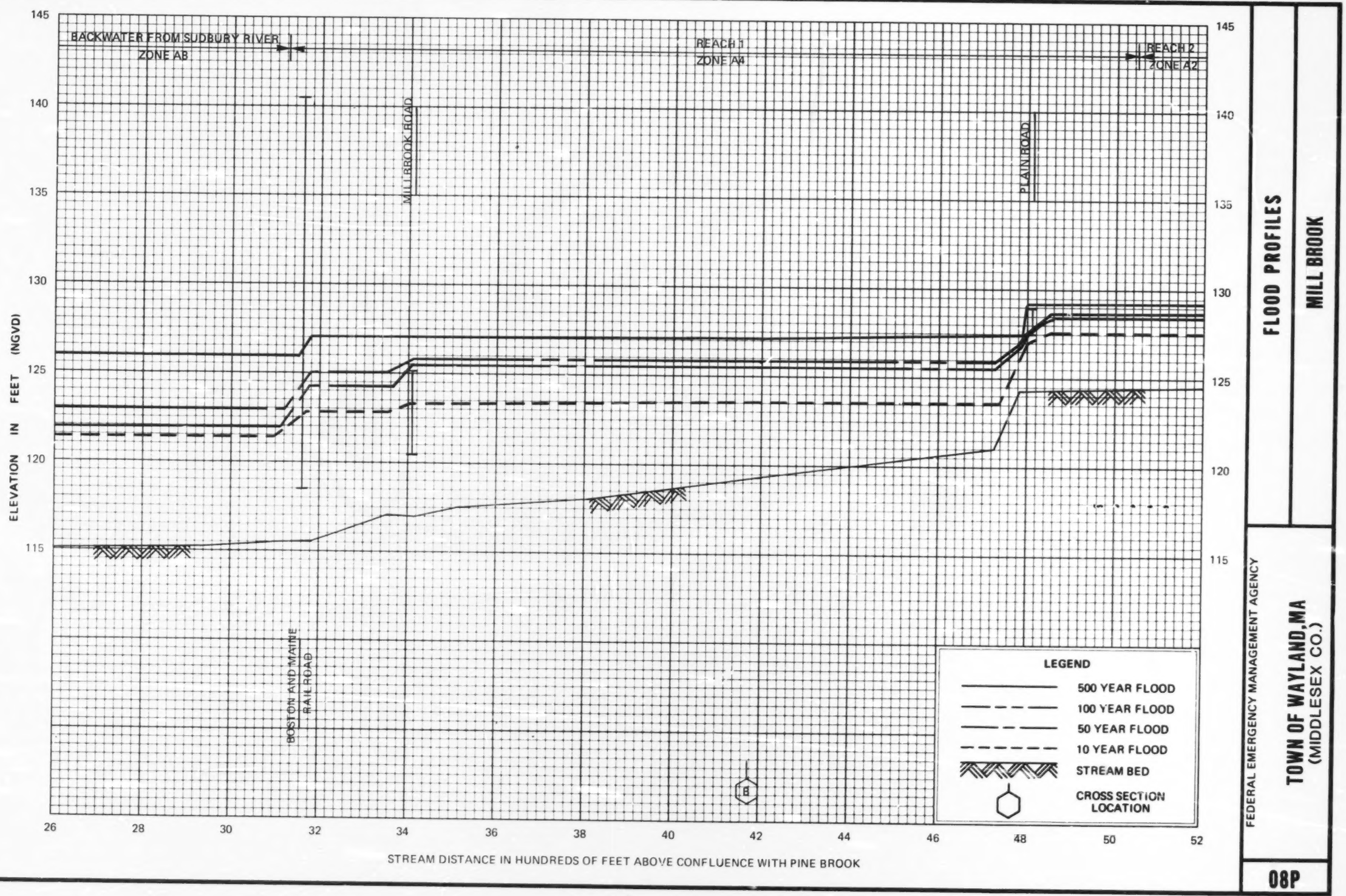

FLOOD PROFILES

MILL BROOK

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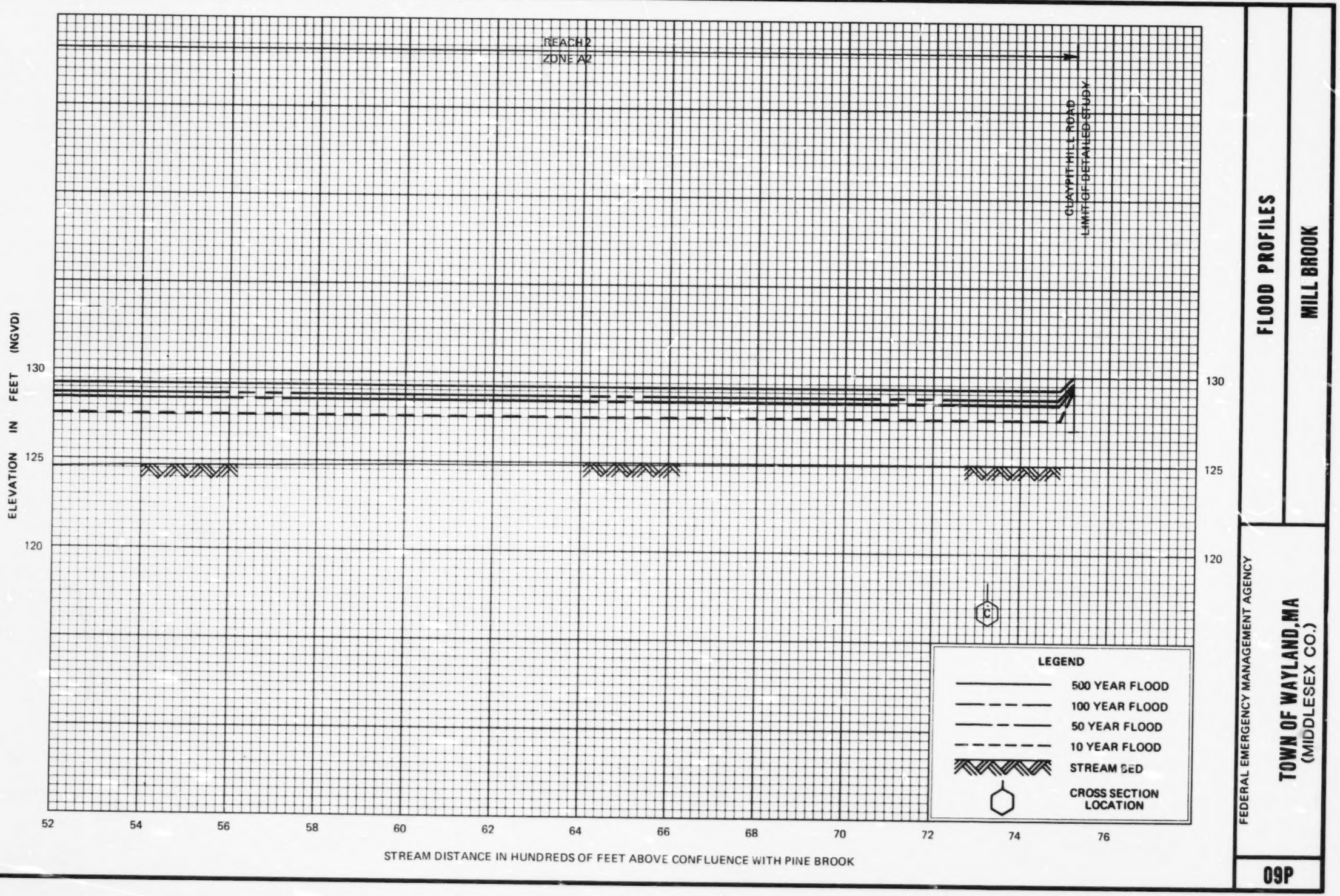

FLOOD PROFILES

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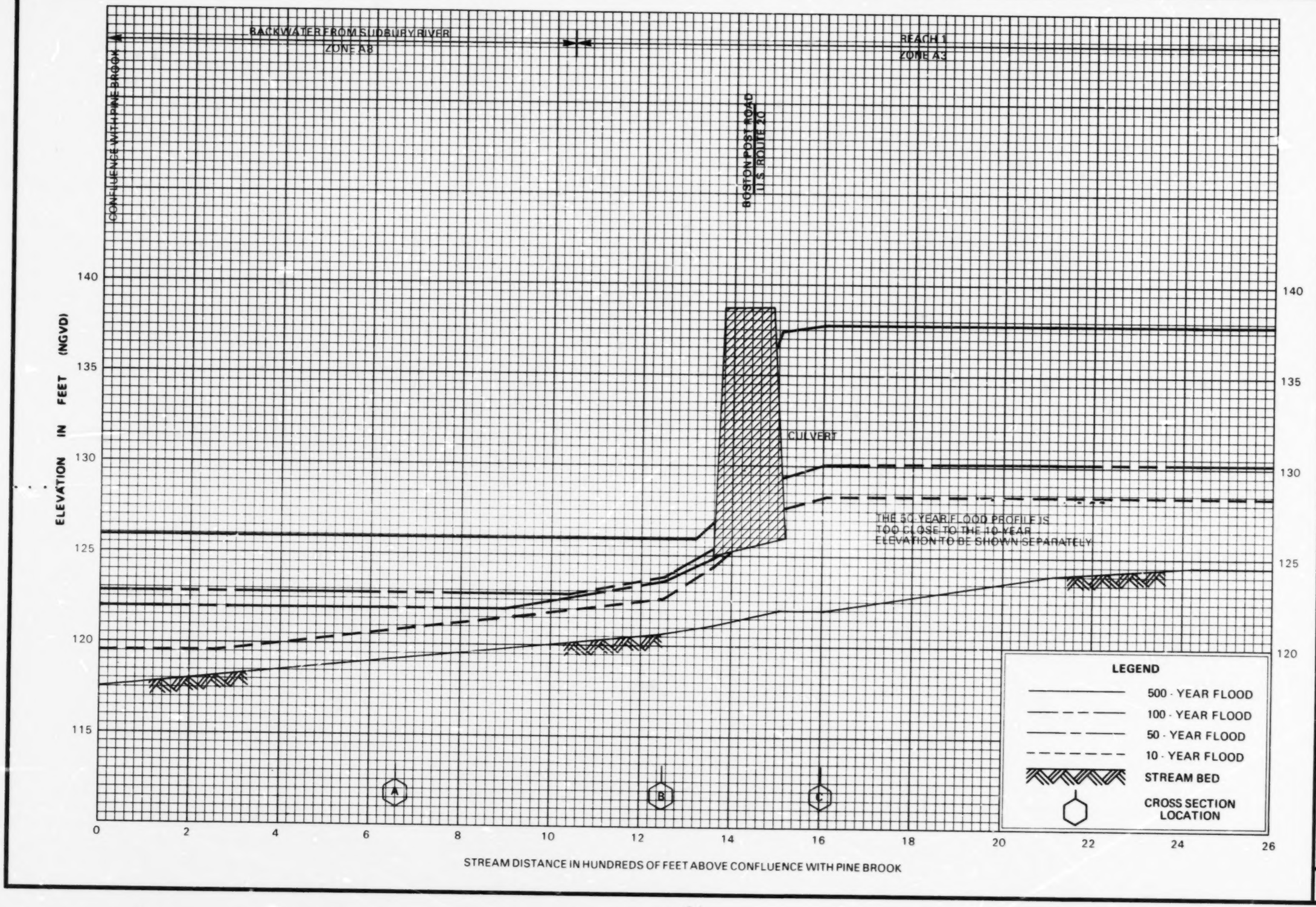

FLOOD PROFILES

HAYWARD BROOK

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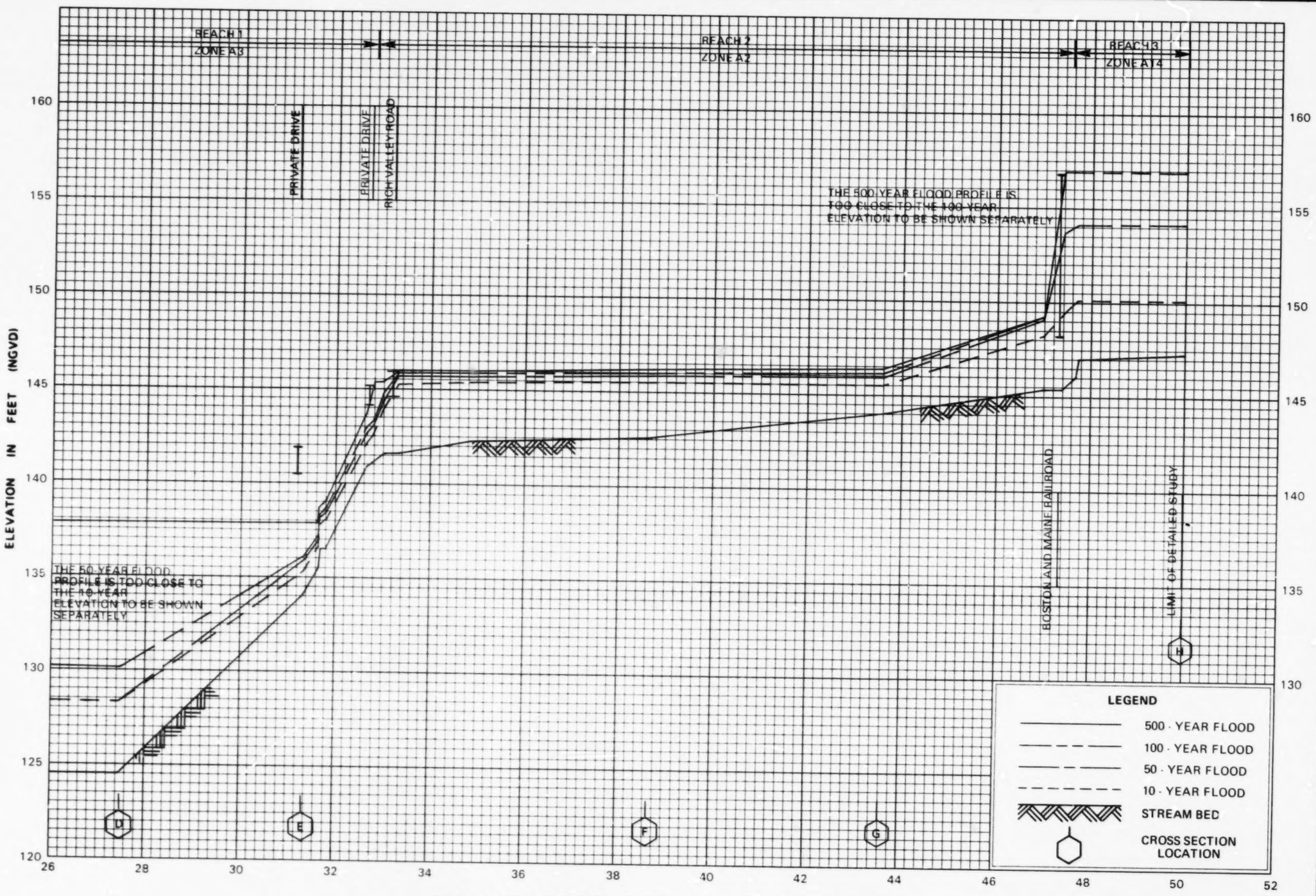

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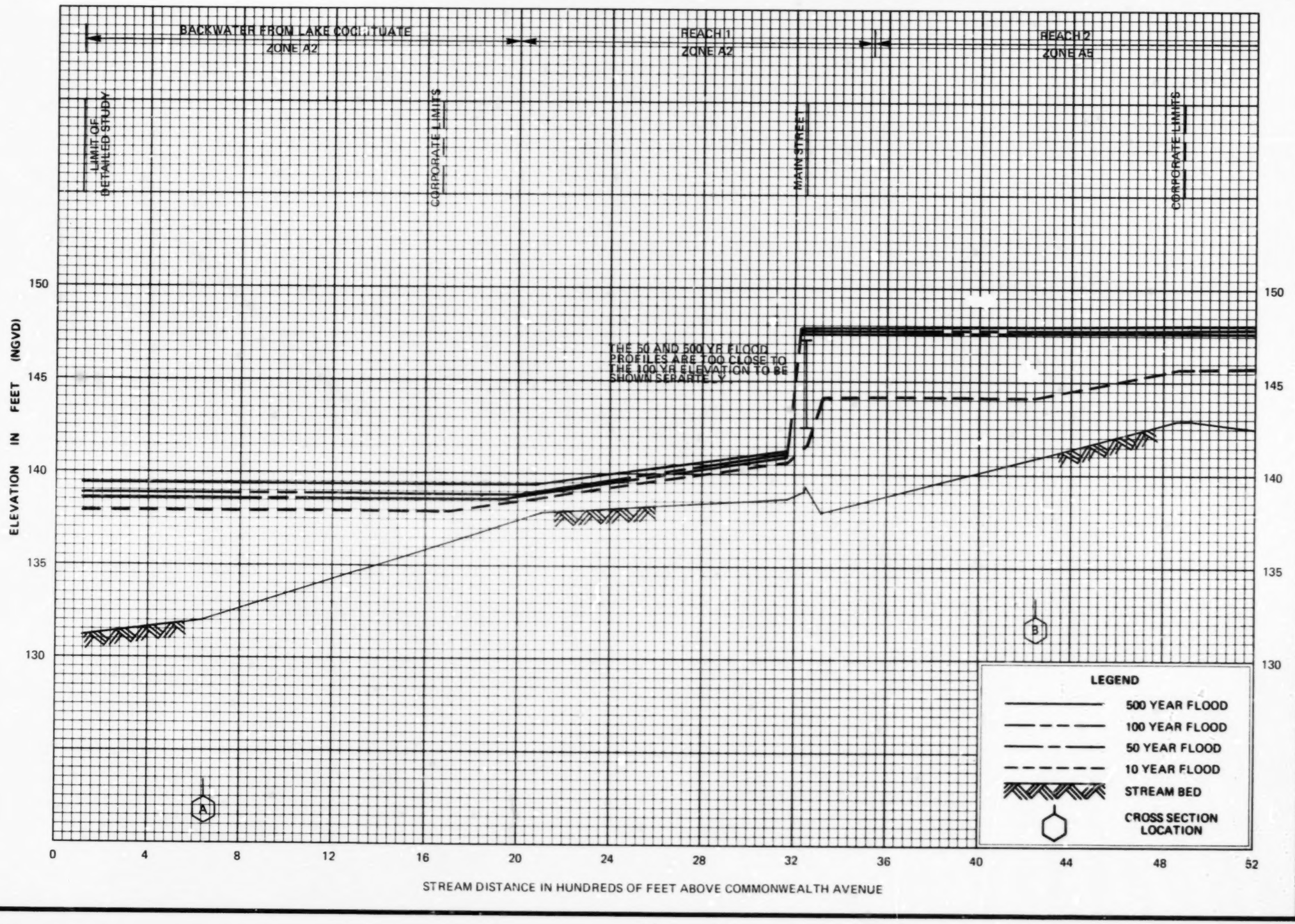

FLOOD PROFILES

SNAKE BROOK

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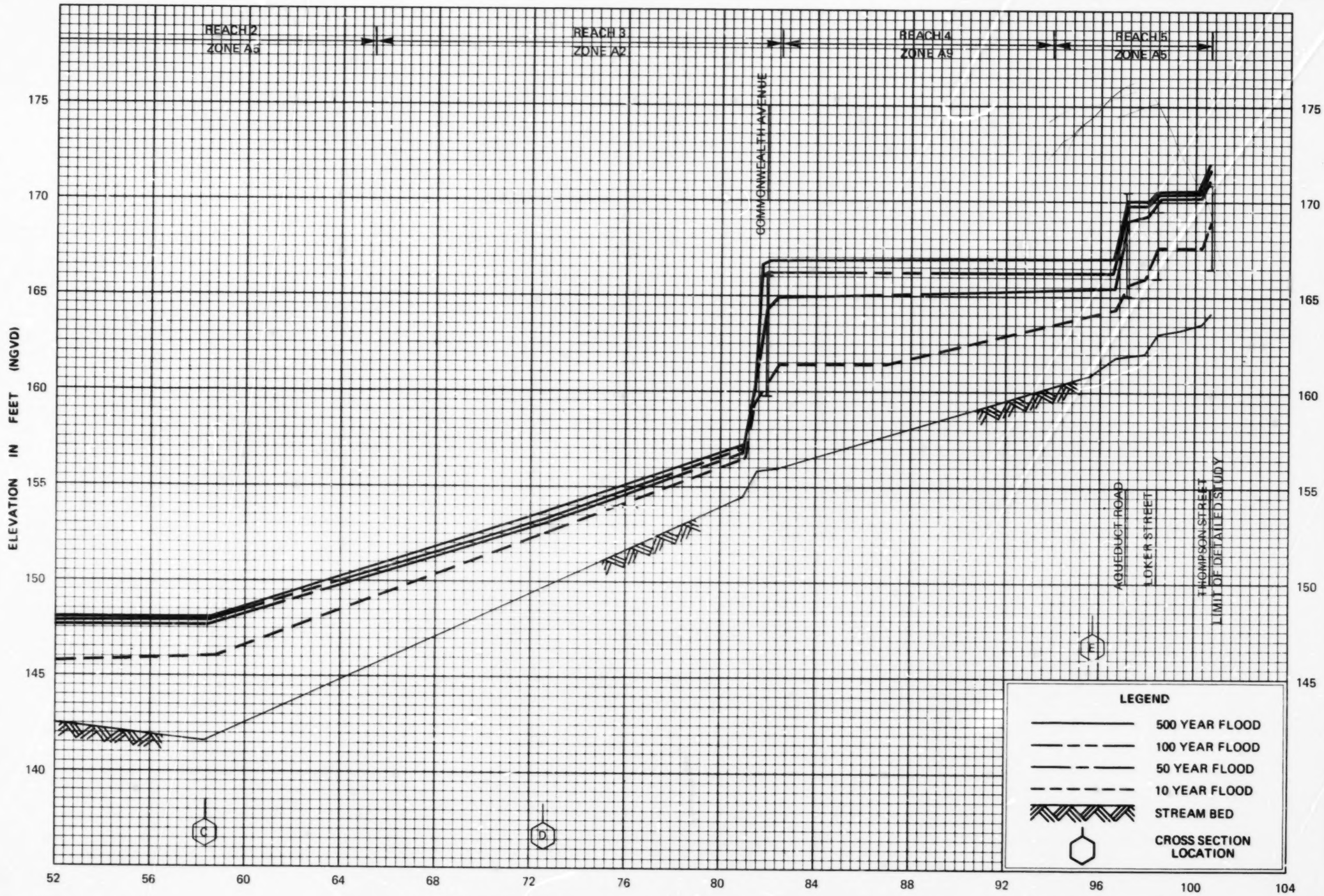

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